Communications Requirements and Analysis for New and Emerging FAA Applications

Mark Simons

MITRE/CAASD

Requirements Analysis - Purpose

- **Determine the collective impact of new and emerging FAA systems on the access architecture that connects an FAA facility with a vendor's network point of presence (POP)**

- **Estimate aggregate access bandwidth requirements and latency for these new and emerging systems**
  - **Accurate sizing of access bandwidth is key to providing cost-effective service**
  - **Latency is a critical performance parameter for some FAA applications**

MITRE

CAASD

Requirements Analysis - Approach

- **Select New and Emerging NAS applications**
  - New applications or updates to current applications
  - Operational 2002-2005
- **Develop individual system requirements**
  - Bandwidth and latency
- **Define notional model of access architecture**
  - Not intended to endorse a specific architectural approach
- **Employ a queuing modeling tool to determine aggregate bandwidth requirements and latency**
- **Interpret results**
  - Study trade-offs between latency and bandwidth

MITRE

CAASD

New and Emerging FAA Applications

- **Decision Support Systems**
  - **Traffic Flow Management-Infrastructure (TFM-I)**
    - **Enhanced Traffic Management System (ETMS)**
    - **Departure Spacing Program (DSP)**
    - **Runway Visual Range (RVR)**
    - **Ground Delay Program (GDP)**
    - **Collaborative Reroute and Coordination Tools (CRCT)**
  - **Military Operations and Support (MILOPS)**

MITRE

CAASD

New and Emerging FAA Applications

- **Navigation and Surveillance**
  - **Wide Area Augmentation System (WAAS)**
  - **Flight Information Service - Broadcast (FIS-B)**
  - **Automatic Dependent Surveillance - Broadcast (ADS-B)**
  - **Traffic Information Service - Broadcast (TIS-B)**
  - **Airport Surveillance Radar(ASR)**
  - **Air Route Surveillance Radar (ARSR)**

New and Emerging FAA Applications

- ## Automation
  - **User Request Evaluation Tool (URET)**
  - **Problem Analysis Resolution and Ranking (PARR)**
  - **Standard Terminal Automation Replacement System (STARS)**

- ## Air/Ground Communication
  - **Controller-Pilot Data Link Communications (CPDLC)**

- ## Weather Systems
  - **Weather and Radar Processor (WARP)**
  - **Integrated Terminal Weather System (ITWS)**
  - **Operational and Supportability Implementation Systems (OASIS)**

MITRE

CAASD

Estimated Requirements for Individual Systems

	Bandwidth			One Way Latency		
	> 1 Mbps	< 1 Mbps; > 100 kbps	< 100 kbps	< 100 ms.	> 100 ms; < 1000 ms	> 1000 ms
STARS	• •			•		
WARP	•		•			•
ITWS	•		•			•
WAAS	•	•	•	•		
TFM-I		•				•
Radar Services		•		•		
URET			•	•		
PARR		•		•		
SAMS/MILOPS			•		•	
FIS/TIS/ADS-B			•		•	
CPDLC/ATN			•		•	
OASIS			•			•

MITRE

CAASD

Requirements Analysis - Modeling

- **Tools**
  - NetMaker Mainstation from Make Systems
  - Uses analytical methods based on queuing theory

- **Scenarios**
  - Generalized ARTCC
  - Generalized TRACON

MITRE

CAASD

Requirements Analysis - Inputs

Model Parameters for Generalized ARTCC

System	Traffic Model	Baseline Scenario Parameters		Peak Scenario Parameters	
		Input	Output	Input	Output
ASR-11	CBR	280 Kbps	n/a	280 Kbps	n/a
ARSR/ATCBI	CBR	316 Kbps	n/a	316 Kbps	n/a
Broadcast	CBR	25 Kbps	64 Kbps	64 Kbps	64 Kbps
CPDLC	Poisson	n/a	40 Kbps	n/a	128 Kbps
MILOPS	Poisson	64 Kbps	n/a	64 Kbps	n/a
TFM-I/CRCT	Poisson	150 Kbps	n/a	256 Kbps	n/a
URET	Poisson	80 Kbps	70 Kbps	110 Kbps	100 Kbps
PARR	Poisson	100 Kbps	80 Kbps	200 Kbps	160 Kbps
WARP	CBR	1.5 Mbps	n/a	1.5 Mbps	n/a

MITRE

CAASD

9

Requirements Analysis -Results

Model Results from Generalized ARTCC

ARTCC Model	ARTCC Access Link Utilization		Latency Across Access Link
2 T1 Access Link	Input	Output	
Baseline Model	99%	17%	154 ms
Peak Model	103%	24%	n/a
3 T1 Access Link	Input	Output	
Baseline Model	66%	11%	3.9 ms
Peak Model	71%	18%	4.6 ms
4 T1 Access Link	Input	Output	
Baseline Model	50%	8%	2.2 ms
Peak Model	54%	13%	2.4 ms

Model Results from Generalized TRACON w/o STARS

ARTCC Model	ARTCC Access Link Utilization		Latency Across Access Link
2 T1 Access Link	Input	Output	
Baseline Model	87%	5%	12.2 ms
Peak Model	91%	9%	15.7 ms
3 T1 Access Link	Input	Output	
Baseline Model	53%	33%	3.3 ms
Peak Model	60%	6%	3.4 ms
4 T1 Access Link	Input	Output	
Baseline Model	44%	3%	2 ms
Peak Model	45%	4%	2.2 ms

MITRE

CAASD

Requirements Analysis - Summary

- **Equivalent of 3 T1s of access bandwidth will be needed at an ARTCC**

- **Equivalent of 8-28 T1s of access bandwidth will be needed at a TRACON**

  - Driven by the number of connected towers and final STARS implementation

  - Initial estimates for STARS call for the equivalent of 3-5 T1s of access bandwidth per ATCT/TRACON pair

- **Results should aid forecasting of growth requirements for the planned FAA Telecommunications Infrastructure (FTI)**